group, but too small to be of any consequence. It had disappeared by the 19th. * * * on the morning of the 17th telegraph operators noticed a disturbance.—*E. D. Roe, jr.*[23]

Mr. Owen Bryant reports that the "aurora was bothering the wires again on the morning of April 20 [at Calgary]," but the weather did not permit him to observe any display. Auroras were reported as seen in New England on the nights of April 14, 16, 17, 18, 19, and at Jericho, Vt., only, April 20–22. The aurora of the 16th was also seen at Ottawa, Canada, that of the 17th at Plainfield, N. J., and that of the 19th extensively throughout New England, and, possibly, through a rift in the clouds at Washington, D. C.

On the following presentation, a faint aurora was observed at Washington, D. C., on the night of May 9, and another by Mr. W. A. Bentley at Jericho, Vt., and by Prof. G. R. Wieland at New Haven, Conn., on the night of May 15–16. Other auroras have not been reported, and from the waning character of the displays at successive rotations of the sun it appears that the unusual solar activity has ceased.

We shall be fortunate if we ever see the equal of this marvelous aurora. Such are rare indeed anywhere in middle latitudes. (See Table 1.) Four potential auroras

TABLE 1.—*A list of the principal auroras from 1914 to 1920, inclusive.*[1]

Year.	Greatest.	Great.	Unusually brilliant.
1914....	None.....	None.....	None.
1915....	June 16–17.....	None.....	{Oct. 6–7 (Iceland).} {Nov. 14–15 (Iceland).}
1916....	Aug. 26–27.....	None.....	None.
1917....	.....	{Aug. 9–10..... {Dec. 16–18.....	Jan. 4.
1918....	Mar. 7–8.....	Aug. 15–16.....	May 15–17.
1919....	Aug. 11–12.....	Oct. 1–3.....	{Feb. 27–28. {May 2.
1920....	March 22–23.....	.....	

[1] Many of these displays are described in the MONTHLY WEATHER REVIEW for the years indicated.

may pass unnoticed in the daytime, in the latter half of night, or behind the clouds, for each one that a person can see on a clear evening. We can count only five such great world-wide auroras during the past five years embracing this unusual sunspot maximum. Our turn is not likely to come again for 20 years.

NOTE ON THE HEIGHT AND LOCATION OF THE AURORA SPOTS AND BELT OF MARCH 24, 1920.

By CHARLES F. BROOKS and C. LEROY MEISINGER.

[Weather Bureau, Washington, D. C., May 10, 1920.]

In comparing the notes of various observers of the aurora of the night of March 24–25, it appears that some of the spots and patches observed in various places were identical, but that they appeared in various parts of the sky to the various observers. This makes it easily possible to calculate the altitude of the aurora and determine its location. For example, a certain spot was simultaneously seen from South Hadley, Mass., Concord, Mass., Rochester, N. Y., and Washington, D. C. Prof. Anne S. Young at South Hadley saw it in the southwest at an altitude of about 15°, Mr. Milroy N. Stewart at Rochester saw it in the southeast at about the same elevation, and at Washington it was observed in the northeast-by-north at an elevation of 35° to 40°. While Mr. Fred A. Tower at Concord certainly saw the same spot, the reported elevation seems to have been estimated somewhat too large, it being reported as 40°. These lines meet in an area over southeastern Pennsylvania and central New Jersey, and trigonometrical calculation shows that its height was about 140 kilometers (87 miles).

Again, the May, 1920, issue of *Popular Astronomy*, pages 307–312, gives some interesting photographs and reports. One of these photographs, taken about midnight, March 24, in Brooklyn, N. Y., shows an auroral spot in the southeast together with several star trails, among which the most conspicuous were those of Mars and Spica. This spot was observed in Washington, between east by south and east-southeast within a few degrees of the horizon. Measuring on the photograph made at Brooklyn it is possible to determine with fair accuracy the angular altitude of the auroral spot at that place, and its center is found to be about 13°. If lines are drawn toward the southeast from Brooklyn and toward a point between east-by-south and east-southeast from Washington, it is found that they intersect in the ocean about 320 km. from Brooklyn and 470 km. from Washington. Using the Brooklyn elevation, we find the altitude of the spot to be about 120 kilometers (73 miles).

Another case, taken in part from the reports in *Popular Astronomy*, is that of an observer in Ann Arbor, Mich., reporting a bright patch in the south about 20° above the horizon at 11 p. m. 90th meridian time. From Washington, this spot appeared in the west-by-north about 7° above the horizon. Calculation shows it to have been about 330 km. south of Ann Arbor, and 610 km. west-by-north of Washington at a height of about 130 kilometers (81 miles).

All these values being in very good agreement, it is reasonable to assume that the display was taking place at that general elevation; or, to take the mean of the three calculations, 130 kilometers (81 miles). Making this assumption as to the altitude, it is possible to locate other spots which were observed from Washington. Such a one was seen in the northwest to northwest-by-west or west-northwest at about 9:45 p. m., appearing as lenticular in form with its lower edge at an elevation of 18° and its upper at 23°. Assuming this to have been actually a flat base and its elevation 81 miles, we find that the more distant edge must have been 400 km. from Washington and its nearer edge about 300 km. This would place it over east central Ohio and western Pennsylvania. Mr. H. D. Pallister, writing from eastern Kentucky, says:

"I also saw the aurora on March 24 about 9:30 p. m. (C. S. T.?) at Wolfpit, Pike County, Ky., and watched it for over one-half hour. As seen here it consisted of undulating flashes of white light radiating from a general northerly direction. The flashes would occur at intervals growing brighter and then die out for a time."

The two spots over eastern and western Pennsylvania early in the evening, grew into a belt stretching from a few hundred miles out to sea, across northern Virginia to southwestern Ohio. Although the belt seemed to move slowly, it was traveling southward at about 60 miles an hour.

THE PHYSICS OF THE AURORA.[1]

By W. J. HUMPHREYS.

[Abstract.]

We are fortunate in having collected in one book practically all that is known concerning the aurora:

[23] Science, May 14, 1920, p. 486.

[1] Presented before American Meteorological Society, Washington, D. C., April 22, 1920.

"Bericht über die neueren Untersuchungen am Nordlicht," by L. Végard.[2] This is a very complete bibliographic and mathematical discussion of the subject. The height of the aurora has been determined accurately by simultaneously photographing the same aurora from two stations against a common background of stars, and measuring the parallax obtained. The lower limits of the aurora vary from perhaps 85 kilometers to 170 kilometers, with two well-defined maxima, at 100 and 106 kilometers. The tops extend to heights exceeding 300 kilometers. The magnetic effects accompanying auroras show that they are owing to moving electrons, and their coming most at times of maximum sunspots shows connection with solar disturbances. The electrified particles make the luminosity. Most of the spectral lines are nitrogen lines, but the most prominent one, the "auroral line" is a greenish line of wave length not fitting any known element. The nearest line is a krypton line, but the other krypton lines are not present. [See abstract immediately following this.]

The aurora seems to be caused by electrified atoms discharged from an active area on the sun, which atoms are in part intercepted by the earth's magnetic field and guided toward the magnetic poles. As the particles follow the lines of force in the earth's magnetic field, the visible auroral streamers, which are produced by their action on the atmosphere, are practically straight lines, and therefore produce the coronal or ribbed-dome effect observed whenever an auroral arch with streamers passes through the observer's magnetic zenith.[3] The dark hole (frequently observed at the center of the corona) is the perspective effect produced on looking along the streamer lines.

The electrons have a penetrating power which can carry them through the atmosphere down only to an altitude at which the atmosphere reaches a certain density. Since the particles that form the usual aurora seem to have about equal penetrating power, the under limit is sharply defined and at about the same altitude.

When the aurora reaches a certain degree of intensity, electrical discharges take place, and first where the resistance is least, namely, in the strongly ionized air at its lower limits. The breakdown thence spreads rapidly upwards giving the impression of a rapidly upward moving wave of light.[4]

The variations in the intensity of the aurora probably depend on the varying abundance of arriving particles from the sun, as well as upon the position of the bright spots relative to the observer.—*C. F. B.*

GENERAL AURORAL ILLUMINATION OF THE SKY AND THE WAVE-LENGTH OF THE CHIEF AURORA LINE.

By V. M. SLIPHER.

[Reprinted from Science Abstracts, sec. A, Sept. 30, 1919, §1165. Abstracted from Astrophys. Jour. 49: 266–275, May, 1919.]

During the past three and one-half years about a hundred spectrograms have been made at the Lowell Observatory of the night sky, and every one of these has recorded the chief aurora line. The spectrograph, therefore, gives direct evidence of the existence of permanent auroral illumination of the sky. The close dependence of displays of aurora upon sun-spot activity suggests that there are variations in the intensity of this general illumination due to the aurora. A preliminary determination of the wave length of the aurora line indicated a longer wavelength than the commonly accepted value λ5571. Further measurements on plates obtained with a higher-dispersion spectrograph gave a mean value for the wave length of λ5578.05. The plates showed clearly that the line falls well to the red side of the strong solar line λ5573.075, and so the value λ5571 must be considerably in error. Stark [Abs. 745 (1918)] has put forward the view that the origin of the chief aurora line is probably the nitrogen pair λλ5560, 5565, but the new value obtained for the wave-length renders this view quite inadmissible.—*A. W.*

[2] Jahrbuch der Radioaktivität und Electronik, 1917, vol. 14, pp. 383–465, 7 figs., 5 tables.
[3] Cf. *Science*, May 14, 1920, N. S. vol. 51, p. 485.
[4] See the more detailed discussion by S. Chapman, "Electrical phenomena in the upper atmosphere;" reprinted in *Sci. Amer. Suppl.*, Sept. 27, and Nov. 29, 1919, pp. 198, and 323; abstracts in *Nature* (London), June 19, 1919, p. 311, and MONTHLY WEATHER REVIEW, Dec., 1919, 47: 879.

AURORA OF MARCH 4–5, 1920.

[Reprinted from Nature (London), May 13, 1920, p. 337.]

A short article in our issue of March 11, page 56, describing a magnetic disturbance which occurred on March 4–5, mentioned that aurora had been observed at Aberdeen on March 4, but considerably earlier than the commencement of the disturbance, and so presumably not directly connected with it. This seems to have been the only observation of aurora in this country on either March 4 or 5. A letter, however, which we have received from Prof. A. S. Eve, of Montreal, mentions a brilliant aurora as having been observed there between 1 a. m. and 2 a. m. G. M. T. on March 5, and so synchronous with the magnetic storm. Commencing with isolated patches, the aurora appeared for a short time in the form of an arc and ended in a curtain display. This incident leads Prof. Eve to inquire whether there is in existence "an organization for recording, with accurate timing, auroras in both northern and southern hemispheres, and, if so, where can the records be obtained?" So far as we are aware, no such records exist. The question seems to merit the consideration of the recently instituted Section of Terrestrial Magnetism and Electricity of the International Geodetic and Geophysical Union.

AURORAS OF 1919 IN THE UNITED STATES.

By HERBERT LYMAN.

[Weather Bureau, Washington, Aug. 31, 1920.]

The following tables of auroras observed in the United States during the year 1919 are based on two sources of data. First, the original monthly meteorological reports of all regular Weather Bureau stations; second, the published "Climatological Data," compiled each month by the several section centers under the supervision of the Climatological Division of the Bureau. The section reports are not, however, all uniform in the matter of listing "Miscellaneous meteorological phenomena" (under which auroras are classed) so that the tables here presented are not all-inclusive. But while there were a few instances where no record was kept of auroral displays, in the main the tables below are reasonably accurate.

Upon examining table 1, one is rather surprised to note the large number of days on which auroras were seen. Thus for the entire year there were 171 auroral displays reported—an average of one aurora to every